

Chapter 1

STREAM BIOASSESSMENT: A FRAMEWORK FOR MONITORING

Biological assessments of aquatic communities, also referred to as bioassessments, are rapidly becoming a critical tool for water quality monitoring and are gaining popularity among scientists, resource managers, and decision makers alike. To fully understand the concept of bioassessments, it is important to know not only what they are, but also to understand the rationale for conducting them and how they can be used as a decision-making tool. The following text describes the rationale for conducting bioassessments including; 1) definitions of bioassessment and biocriteria, 2) utility of bioassessment as a decision-making tool, 3) success of bioassessment programs in other states, and 4) limitations. The application of bioassessment in California as well as the objectives of this report are described in this chapter.

1.1 The Role of Bioassessment in Water Quality Determination

State and tribal water resource agencies in the U.S. have developed bioassessment approaches that have added an important dimension of ecological understanding to their already overburdened and under-funded monitoring programs (Barbour 1997). The central purpose of assessing the biological condition of aquatic communities is to determine how well a water body supports aquatic life (Barbour et al. 1996a). Biological communities integrate the effects of different pollutant stressors such as excess nutrients, toxic chemicals, increased temperature, and excessive sediment loading, and thus provide an overall measure of the aggregate impact of the stressors. Use of information about ambient biological communities, assemblages, and populations to protect, manage, and even exploit water resources has been developing and evolving for the past 150 years (Davis 1995). Despite this long history, it has only been in the last decade that a widely accepted technical framework has evolved for using biological assemblage data for assessment of the water resource (Barbour et al. 1996a).

1.1.1 Definition of Bioassessment and Biocriteria

Biocriteria are narrative descriptions or numerical values adopted into state or tribal water quality standards that can be used to factually and quantitatively describe a desired condition for the aquatic life in waters with a designated aquatic life use. The purpose of biocriteria is to establish standards based on biological characteristics that will protect the designated aquatic life use that can be used to direct water quality management. Biocriteria are developed by biologists and other natural resource scientists using accepted scientific principles to characterize the regional reference conditions for the different water bodies found within a state or tribal nation. Biocriteria depend on bioassessments as the scientific basis for making informed decisions regarding the aquatic resource. Bioassessment, on the other hand, is an evaluation of the condition of a waterbody using biological surveys and other direct measurements of the resident biota (i.e., fish, macroinvertebrates, periphyton). This report will focus primarily on bioassessments using benthic macroinvertebrates.

Bioassessments –

- directly measure the response of a biological community to disturbance and restoration actions.
- establish a benchmark of expected conditions.
- provide indication of impairment from multiple and cumulative stressors.

Biocriteria –

- assist in setting state water quality standards.
- help shift the emphasis of preservation and restoration goals from performance-based standards to impact-based standards.
- assist in setting restoration goals.

1.1.2 Utility of Bioassessment as a Decision-making Tool

Biological assessment provides crucial water quality planning information for managing complex water quality problems. Biological assessment serves four primary functions or uses:

1. Screening or initial assessment of conditions
2. Characterizing the magnitude of impairment
3. Assisting in the diagnosis of causes to impairment
4. Monitoring of temporal trends to evaluate improvements or further degradation

States and tribes are faced with the challenge of developing monitoring tools that are both appropriate and cost-effective, and that will provide comprehensive survey coverage of their water resources (Barbour 1997). The purpose for a water resource agency to establish an effective assessment and monitoring program is fourfold:

1. Assess attainment of water quality standards (per CWA §305[b]) and listing of impaired waters (per CWA §303[d]).
2. Identify causes and sources of impairments to support control strategy development including Total Maximum Daily Loads, or TMDLs, (e.g., use of biological response signatures – see Yoder and Rankin 1995, Simon 2002).
3. Evaluate changes in water quality in response to ongoing management actions to gauge level of success and guide strategy revisions.
4. Involve the public to increase their understanding of the environment, build working relationships and trust, and increase information available on water quality and stressors.

The advent of bioassessment in regulatory programs has provided a more comprehensive and effective monitoring and assessment strategy, which is described in detail in USEPA's Clean

Water Action Plan (USEPA 1998). In many instances of impairment, biological measures are better than chemical measures at reflecting the condition of the aquatic ecosystem (NRC 2001). Consequently, the use of bioassessments and biocriteria in state and tribal water quality standards programs has become a top priority of the U.S. Environmental Protection Agency (USEPA 2000). As such, one of the agency's objectives is to ensure that all states and tribes develop water quality standards and programs that use bioassessment information to evaluate the condition of aquatic life in all waterbodies (USEPA 2000). Furthermore, the development of biological criteria (biocriteria) within regulatory programs to serve as thresholds by which to judge the attainment of designated aquatic life conditions of surface waters is a major focus of states and tribes within the US (Barbour et al. 2000).

1.1.3 Success of Bioassessment Programs in other States

The last decade has been a period of progressive advancement in the development and implementation of bioassessment in the US. In 1989 when the Rapid Bioassessment Protocols were first introduced to state programs (Plafkin 1989), very few states and no tribes had viable bioassessment programs in place. In 1994, twenty states were beginning a biological monitoring program for streams and rivers, and fourteen states had biological programs in place (Davis et al. 1996). However, only eleven were developing or had developed biocriteria based on their monitoring programs. In contrast, by the year 2000, most states had established biological

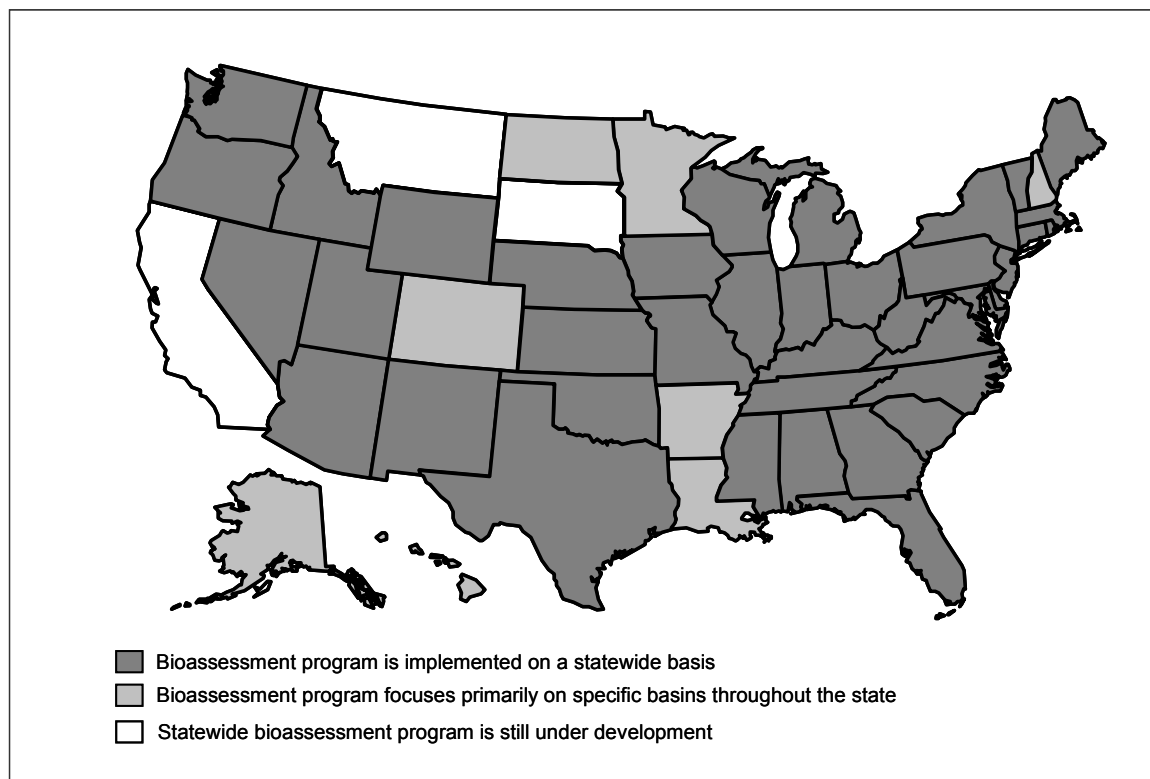


Figure 1. Current status of bioassessment programs (USEPA 2002, Draft).

monitoring programs for streams and rivers, and were developing or had developed quantitative biocriteria. As of 2001, only three states, including California, have yet to establish a concerted bioassessment program (Figure 1), and half of the states have at least 10 % of their streams/rivers assessed for biology (Figure 2). The states and tribes that have been the most progressive in developing biocriteria based on biological assessment include Idaho, Ft. Peck Affiliated Tribes, Maine, Vermont, Maryland, Ohio, Florida, Arizona, and Oregon. The development of bioassessment and biocriteria for bodies of water other than streams or rivers is a more recent phenomenon.

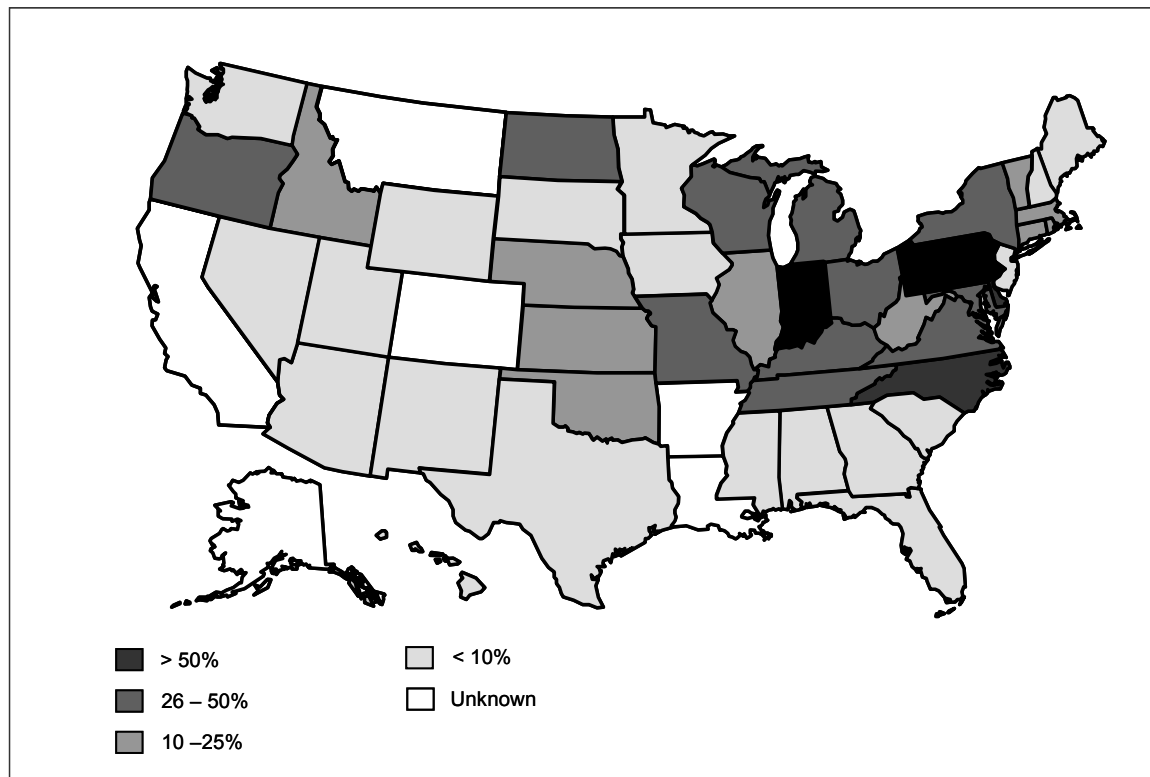


Figure 2. Percent of stream/river miles assessed using bioassessments (USEPA 2002, Draft).

Biocriteria programs begin with the development of a bioassessment framework. Expertise in ecological principles and resource investment by the agency is required to develop this framework and to implement biocriteria. State agencies vary in their investment of resources and effort in this process. In addition, the time frame for development, calibration of a biological indicator for assessment, and implementation is dependent upon resource investment and the ability to gather and compile data. Most states are able to develop the technical framework for bioassessment in less than five years (e.g., Arizona, Florida, Maryland, Wyoming).

1.2 Application of Bioassessment and Biocriteria in California

Historically, the use of bioassessment data in California water regulations and decision-making has not been a high priority. One of the first management actions was in 1993 when the Lahontan Regional Water Quality Control Board (RWQCB 6) required the use of EPA's Rapid Bioassessment Protocols in a fish hatchery permit. Furthermore, in 1993 the California Department of Fish and Game's Water Pollution Control Laboratory in Rancho Cordova began building the infrastructure necessary to develop biocriteria, including an Aquatic Bioassessment Laboratory (ABL) with field and laboratory capabilities large enough to support the bioassessment needs of the State and Regional Boards and other water resource management agencies. In addition, they developed and promoted standardized field and laboratory protocols (California Stream Bioassessment Procedure (CSBP)) for assessing biological integrity in wadeable streams and rivers. Since that time, bioassessment has steadily increased in use in water resource decision-making. Presently, bioassessment is used as an additional tool to NPDES and stormwater permitting to supplement the chemical and toxicological information obtained to address chemical standards. The recent organization of California's Surface Water Ambient Monitoring Program (SWAMP) is providing the impetus to implement a better organized and standardized biological assessment and monitoring program throughout the state. Current concerns over hydroaugmentation and use attainability analyses of targeted waterbodies will foster a greater dependence upon bioassessment information in making informed decisions regarding the protection and restoration of California's streams.

This project is an extension of the SWAMP program and is an attempt to identify and characterize viable bioassessment programs in California's streams. As such, five objectives were articulated for directing this project and resulting report. They are as follows:

1. *Summarize the historical significance of stream bioassessment in California (1992-2000).* Bioassessment development is historically varied and diverse in California. During this period, application of biological survey and assessment techniques was highly oriented toward watersheds and differed among regions of California.
2. *Provide an overview of current statewide bioassessment efforts (2000-present).* With the advent of improved technological advances in bioassessment, certain methods and procedures have come to the forefront as methods of choice for broad-scale assessments.
3. *Highlight candidate programs that can serve as foundations for bioassessment in California.* A few candidate programs encompass the concept and purposes of bioassessment, such that they are viable models for developing a statewide bioassessment approach.
4. *Discuss the future direction of stream bioassessment in California.* Ideally, a single bioassessment approach will emerge that best represents a method that can be used by various agencies and other entities to judge the biological condition, and thus ecological health, of California's streams.

5. *Assist in guidance for database development.* A uniform database to compile and house the multitude of bioassessment data provides a mechanism for integrating ecological data for statewide assessments. The database becomes a central repository where quality control of data integrity and taxonomic standardization can be conducted to ensure comparability.